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THE EFFECTS OF PROTOTYPING TECHNOLOGIES ON PRODUCT DESIGN

Abstract: *In this study computer aided prototyping technology; which has been developed to find a functional and efficient solution for the prototype manufacturing demand; will be examined with its application areas and product design concept. In the product design process compatibility tests and upgrade studies are being implemented on the prototype models. Reliable service of the products are being expected through the usage of those products in the market by the different consumers under different circumstances. Since the beginning of the mass production, compatibility tests and upgrades, which are done through prototypes, has become an indispensable phase.*

Computer aided prototyping technologies emerged as a result of the necessity of the production of the prototypes that show resemblance to the finished products and this technology can be considered as a rapidly growing and new technology.

Key Words: *Prototyping, product, design*

1. INTRODUCTION

Industrial design aims to make mass-produced products better, more efficient, and most cost-effective. These clever industrial designs take on the problems of user-friendliness, brand recognition, engineering, aesthetics – and more – to bring you, the consumer, the best products possible (6).

The use of computer-aided design or CAD has changed the design process, as many designers now think through the computer. Also known as virtual models, the major drawback to CAD models is that the depth analysis is limited to the representation on the screen and may not include true perspective representation

Otherway, prototyping is a step in the design process of new or revised products that allows design teams to check products for defects, identify possible areas of improvement, and demonstrate the product to potential investors or the target market. Prototyping your design concepts can be an effective way to illustrate your ideas and get approval/sign-off from your higher-ups, Prototypes give you more opportunities to work concurrently. A good prototype can also encourage investment because they can see it in action and it will be easier for anybody wishing to provide funding, to better understand the value of the product.

In most cases, this process involves making models of varying levels of functionality from a range of materials

using several types of prototype technology.These technologies include subtractive and additive construction and software-based representation.

The first two methods involve removing material from a block or sheet of modeling material or adding material to a model layer by layer. The third prototype technology type is used to demonstrate software products.

Proof of concept is an important part of the design process for new or revised products. Producing a prototype model of a proposed product allows a design team assess the design for functionality, faults, and aesthetic qualities prior to going into the final manufacturing phase.

Prototype models are produced using a variety of techniques and may be fully functional or not at all depending on the results expected of the prototyping process. The most common categories into which prototype technology falls are additive, subtractive, and software groups.

2. PROTOTYPE METHODOLGY

A survey of MIS managers in Fortune 1000 firms [1] suggests that there are four prototyping methodologies in use today which supplement the traditional systems development life cycle:

1) Illustrative: produces only mockups of reports and screens.
2) Simulated: simulates some system functions but does not use real data or a database, model not implemented.
3) Functional: performs some actual system functions and uses real data and/or a database, model not implemented.
4) Evolutionary: produces model(s) that become part of the final operational system [2]

Nowadays, prototype is a very important issue in every industry For this reason firstly, prototype logic will be examined later than give some application of knowledge of prototyping in this paper

3. PROTOTYPE TYPES

Everyone has inventive ideas from time to time, however, what happens if you feel your product idea has commercial value and you want to take it to the next stage and even build a business around it. It will begin work creating the first prototype

In the 1980s, the manufacturing industry began developing what has evolved into rapid prototyping, additive manufacturing, and three-dimensional (3D) printing technology. This technology has provided the ability for designers and engineers to create 3D physical models from 3D computer models (7)

Additive prototype technology, also known as rapid prototyping, makes use of techniques that add material to a blank slate. These include direct metal laser sintering (DMLS), selective laser sintering (SLS) and stereolithography (SLA) techniques.

In most of these processes, a laser is used to trace the model's shape in a fluid or powdered base that solidifies upon contact with the laser beam. Guided by a computer aided design (CAD) representation of the model, the laser gradually builds up the prototype layer by layer until it is complete. Three-dimensional printing (3DP) and electron beam melting are two similar additive prototyping processes.

Subtractive prototype technology utilizes several types of conventional computer numerical control (CNC) machines to remove material from a block of modeling material to reveal the completed prototype. These machines are also driven by the details contained in a CAD file.

Machining is known as a primary subtractive prototyping process. Casting models from resins is also known as a

subtractive process, as material is first machined away from a block of aluminum or plaster to make the molds used. This type of process is known as secondary subtractive prototyping.

Software prototyping technology tends to be far simpler and less costly than the production of physical models. Prototype programs are typically tested as they are developed making bug identification and refinement an ongoing process during development rather than a specific event. Once beta versions have been refined, they are often released for operational testing in a live environment.

4. ADVANTAGES OF PROTOTYPING IN SYSTEMS ANALYSIS

Prototyping, when used as a communication tool between the developers and the users, can help to overcome these problems. As a model of the new system a prototype allows for several forms of communication. First, it allows the developers to communicate to the users their understanding of the requirements.The initial prototype, whatever form it takes, will automatically reflect the developer's understanding of those early requirements.

After viewing/interacting with the initial prototype the second form of communication begins. The users give the developers feedback. Not only will the users correct any misconceptions by the developers, but they will likely recognize misconceptions or requirements they did not anticipate of their own.

From this point on the process is iterative. Developers will make corrections and changes to the prototype based on user feedback and the users will view/interact with the prototype and make changes to the requirements. This continues until they come to an agreement on the requirements or run out of time or money or both. At its best this process provides for very rich user input resulting in well thought out requirements both for the user and the developer [3, 4, 5],

5. THE REQUIREMENTS OF PROTOTYPE

The first step in the development of any new protypet is defining it. It is typical for the initial definition to come from product management, marketing or the company's designated visionary. Initial requirements often consist of a list of specific new features, functions, performance and cost.

The list may include new and revolutionary ideas but, more often than not, simply consists of comparative references, e.g. faster than X, better than Y, less expensive than Z, etc. Also common are 'inverse' requirements, "none of the problems or issues of product X, Y or Z".

Naturally, everyone 'knows' that the list is not comprehensive and does not include 'all' of the requirements. The tacit assumption is that the new product will automatically inherit all of the 'good' characteristics of its predecessor /competitor and none of the 'bad' ones. While the list is not a bad place to start, it is all too common for it to be the ending place as well. The requirements exercise often concludes following a few markups of the list with relatively little discussion or incremental substance or clarity.

When described in this manner, it is obvious that the subsequent product development effort is destined to fail, or at best, produce another small evolutionary step after experiencing numerous changes, delays and budget overruns. Despite the knowledge and experience of the development team, new prototype success is based on a common, shared product vision and the only way to establish and

share that vision is to clearly articulate and document the new prototype.

6. PRE PRODUCTION

When the series production, protoype give us a lot of knowledge. In fact, the prototype is the first product.Other way, pre-production is typically the first time in the new product development process that a meaningful number of the new products are produced in a manufacturing environment under manufacturing control. It is also the first time that production personnel use the final production materials, assemblies, jigs, tests and accompanying work instructions and test limits.

Prior to this stage, prototypes are typically built by a combination of engineering and manufacturing resources in small quantities, using prototyped piece parts and with limited assembly, process and test documentation. While pre-production quantities vary along with the nature of the product, pre-production often consists of 10 to 20 times the number of prototypes that have preceded it.

7. ADVANTAGES OF CAD AND CAM FOR PROTOTYPING

The term CAD/CAM is a very broad term used to refer to a number of technologies primarily used for modelling and designing products, structures, and models.There are actually many benefits and advantages that an individual can derive from CAD/CAM. Due to these advantages, rapid prototyping and manufacturing are made a lot easier.

Using CAD software enables design changes to be made rapidly. Before CAD, a particular design change would have required a draftsperson to completely redraw the design to the new specification. CAD software allows designers to tinker with designs and make small changes on the fly. It can also be used to simulate the behavior of the design in software[6]

Another term for CAM is rapid prototyping. Rapid prototyping allows designers to construct physical prototypes during the design process. These physical prototypes can be used to test various aspects of the design.

For example, if the goal is to design a steel object, then a prototype can be made out of transparent acrylic. The transparency of the acrylic prototype allows designers to view the pattern of stresses and strains within the object. This allows for greater flexibility in the physical design and prototyping process [7]

Having the design in mind and translating it to prototypes is a great way to have a sense of direction. CAD/CAM can help designers see the designs in the most realistic way. During the design process, designers can also check the functionality of the whole product even though it is still a prototype. Because of this advantage, designers can easily identify mistakes in design and modify them before proceeding to the next manufacturing phase.

Nowadays, prototyping technology has contributed a lot to do with CAD and CAM applications.Using CAD software enables the designer to automatically check if the design is within specification. CAD software also enables clients to view designs at an earlier stage in the design process than is usually the case. CAM also enables clients to check the progress of functional and semi-functional prototypes at a much earlier stage than is possible in the traditional design process [8].

CAD and CAM integrated structures has led to the development of rapid prototyping technology.Rapid prototyping technology has changed a lot now in industrial applications. In recent years, rapid prototyping technology (RPT) has been implemented in many spheres of industry, particularly in the area of product development. Existing processes provide

the capability to rapidly produce a tangible solid part, directly from three dimensional CAD data from a range of materials such as photocurable resin, powders and paper.

The time spent using rapid prototyping techniques has decreased by as much as 90% compared to other prototype methods. Creating the tooling for injection molding and other conventional prototyping processes can take days. With rapid prototyping, the same model parts can be made within hours.

The faster a prototype is created, the quicker designers and engineers can analyze it for design flaws and make necessary adjustments. The next step after making these adjustments is manufacturing. A 60 to 90 percent reduction in prototype creation has a direct impact on how quickly companies can release their products to market.

Creating the tooling for injection molding prototypes is not only laborious, but expensive. In addition, tooling can only be used for creating that particular part. Rapid prototyping systems build parts in an additive, layer-by-layer manner. These systems can be used over and over again to build a variety of different parts within their build size [9] [10].

8. CONCULUSION

Multiple disciplines are needed to solve the design problems of today e.g. interaction design, industrial design, designers of environments, human factorsspecialists, mechanical and etc.Each discipline brings a unique understanding of the issues at hand and an individual approach to solving them (8).This information may be obtained from different disciplines will find meaning in the prototype. In particular, advances in computer technology have made great contributions to the prototype technology. The natural result of this, rapid prototype technology has evolved.As a result of rapid mechanical prototyping is to be able to quickly fabricate complex-shaped, 3D parts directly from computer-aided design models.

The key idea of this novel technology is based upon decomposition of 3D computer models data into thin cross-sectional layers, followed by physically forming the layers and stacking them up; “layer by layer technique.” This new method of modeling has raised many attentions in prototyping technology. The result has become almost defect-free products are produced.

REFERENCES

[1] Doke, E.R., "An Industry Survey of Emerging Prototyping Methodologies" *Information & Management* 18 (4) (April 1990) 169-176.

[2] Retrieved from: http://www.umsl.edu/~sauterv/analysis/488_f01_papers/Hammer/term_paper_body.htm

[3] Maner, W., "*Systems Development Approaches*", Retrieved from http://www.uwp.edu

[4] Harrison, R., "Prototyping and the systems development life cycle" *Journal of Systems Management*, 36 (8) (August 1985) 22-25.

[5] McConnell, S., "*Rapid Development: Taming Wild Software Schedules*" Microsoft Press, Redmond, Washington, 1996.

[6] Retrieved from: http://www.ehow.com/info_10002481_advantages-disadvantages-cadcam.html#ixzz2zvj3Oaau

[7] Retrieved from: http://www.ehow.com/info_10002481_advantages-disadvantages-cadcam.html#ixzz2zvjXUim6

[8] Retrieved from: http://www.ehow.com/info_10002481_advantages-disadvantages-cadcam.html#ixzz2zvkjrLxS
[9] Pham, D.T., Gault, R.S. "A comparison of rapid prototyping technologies International Journal of Machine Tools and Manufacture" 38 (10–11) (October 1998) 1257–1287.
[10] Hopkinson, N., Dickens, P., "Rapid prototyping for direct manufacture" Rapid Prototyping Journal, 7 (4) (2001) 197–202.